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PREDICTING STUDENT PERFORMANCE IN A COMPUTER-MANAGED COURSE USI--ETC(U)
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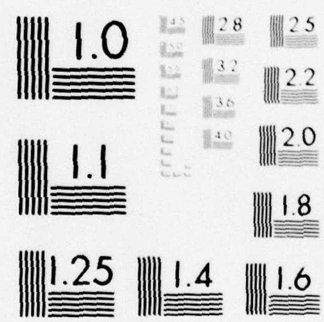

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NPRDC TR 79-30 August 1979

PREDICTING STUDENT PERFORMANCE IN A COMPUTER-MANAGED COURSE USING MEASURES OF COGNITIVE STYLES, ABILITIES, AND APTITUDES

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20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

Measures of cognitive styles, abilities, and aptitudes from a sample of 166 Basic Electricity and Electronics School graduates were analyzed to determine if they were predictive of student achievement and times to complete instructional modules. It was found that the cognitive characteristics can be used to predict student performance.

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FOREWORD

This research and development was undertaken in response to Navy Decision Coordinating Paper, Education and Training Development (NDCP-Z0108-PN) under subproject Z0108-PN.30A, Adaptive Experimental Approach to Instructional Design, and the sponsorship of the Deputy Chief of Naval Operations (Manpower, Personnel, and Training) (OP-01). The goal of this subproject is to design and evaluate procedures for facilitating the instructional systems development (ISD) process.

This is the third of a series of reports prepared under this subproject. The first (NPRDC TR 79-1 of October 1978) identified measures of student characteristics that may be used to develop individualized instructional procedures; and the second (NPRDC TR 79-21 of June 1979), student characteristics that best differentiate failures and graduates of the Basic Electricity and Electronics (BE/E) School. The purpose of the study described herein was to identify those characteristics that are predictive of student performance--in terms of module scores obtained and the times required to complete them.

The results of this study are intended for use by the Chief of Naval Education and Training, Chief of Naval Technical Training, Technical Program Coordinator for the Navy's BE/E Schools, Commanders of the BE/E Schools, and the Navy's Instructional Program Development Centers.

DONALD F. PARKER
Commanding Officer

SUMMARY

Problem

It appears that implementation of computer-managed instruction (CMI) in the Navy's Basic Electricity and Electronics (BE/E) Preparatory Schools has improved training efficiency. To obtain maximum benefit from CMI, however, adaptive instructional strategies that accommodate alternative teaching treatments to student cognitive characteristics must be designed, developed, and implemented. In filling this need, it will be necessary to identify those cognitive styles, abilities, and aptitudes that are predictive of student performance.

Objectives

The objectives of the research were:

1. To identify measures of cognitive characteristics that may be predictive of student achievement in the first 11 modules of BE/E School.

2. To determine whether the predictor pattern changes across the rudimentary modules of BE/E School.

3. To propose procedures for adapting instruction to student cognitive characteristics so as to improve student achievement and reduce the time to complete the basic modules.

Approach

Subjects were 166 BE/E graduates for whom 24 measures of cognitive characteristics had been obtained. Using these data as predictors and module test scores and times to complete the modules as criteria, 22 stepwise regression analyses and two canonical analyses were computed.

Results

1. In 7 of the 11 modules, measures of cognitive styles and/or abilities contributed more to the prediction of student achievement than did measures of cognitive aptitudes. Cognitive styles and aptitudes accounted for more variance in the later modules than the earlier ones; the opposite is true for cognitive abilities.

2. In all 11 modules, measures of cognitive styles and/or abilities accounted for more of the variance in times to complete the modules than did measures of cognitive aptitudes. Cognitive styles and abilities appear to be approximately equally important predictors of times to complete the earlier as well as the later modules; cognitive aptitudes, however, are more predictive in the second than in the first half of the modules.

3. Changes in the proportion of variance in student performance throughout the modules accounted for by certain cognitive attributes represent shifts in their emphasis during the process of acquiring the course content. These shifts in predictor patterns of cognitive styles, abilities, and aptitudes are related to whether students are required by a module primarily to <u>remember</u> or <u>use</u> facts, concepts, principles, and/or rules. Different cognitive characteristics contribute differentially to student performance at distinct modules or stages of learning.

Conclusions

1. Various combinations of cognitive styles, abilities, and/or aptitudes can be used to predict different module test scores and times to complete these modules.

2. Students achieve more in BE/E School if they (a) tend to perceive the environment in a discriminating manner, maximize differences or similarities among objectives, are analytical rather than global in information processing, have a broad range of cognitive categories, and are reflective in their decision making; (b) have high scores in general and logical reasoning abilities as well as verbal comprehension and ideational fluency; and (c) are skilled in numerical operations, space perception, mechanical comprehension, and automotive information.

3. Students successfully complete BE/E modules in less time if they (a) can differentiate objectives or figures from their backgrounds or contents, (b) have high scores in general and inductive reasoning abilities, and (c) are skilled in mathematics, general science, and automotive information.

4. Possible approaches to reducing the BE/E failure rate include (a) excluding students possessing cognitive characteristics associated with failure from BE/E School (assuming a sufficient manpower pool), (b) giving such students special training in deficient areas early in or prior to commencing BE/E School, or (c) developing special instructional strategies based on cognitive characteristics. The latter two alternatives will require additional R&D.

Recommendations

1. The prediction equations derived in this study should be empirically cross-validated, using a large enough number of entering BE/E students to provide sufficient sample sizes. Functions identified based on larger samples and probably Course File 71 instructional materials could be used to predict student achievement and rate of learning within BE/E.

2. The tests of cognitive styles and abilities identified as predictive of student performance in this study should be administered to students before they commence BE/E School to identify those who may benefit from pretraining in deficient areas or the use of specially designed instructional materials. R&D will be required to develop pretraining and/or special instructional materials.

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INTRODUCTION

Problem and Background

It appears that the implementation of computer-managed instruction (CMI) in the Navy's Basic Electricity and Electronics (BE/E) Preparatory Schools has improved training efficiency (Orlansky & String, 1979). To obtain maximum benefit from CMI, however, adaptive instructional strategies that accommodate alternative teaching treatments to student cognitive characteristics must be designed, developed, and implemented. In filling this need, it will be necessary to identify those cognitive styles, abilities, and aptitudes that are related to student performance. Cognitive styles refer to the dominant modes of information processing used by individuals in perceiving, learning, or problem solving; cognitive abilities, to intellectual capabilities; and cognitive attitudes, to job-relevant skills.

To address this problem, Federico (1978) reviewed the literature concerning adaptive teaching systems, and identified those that could be used to accommodate instruction to student characteristics. Federico and Landis (1979) analyzed measures of cognitive styles, abilities, and aptitudes obtained for a sample of 207 BE/E students--172 graduates and 35 failures--to determine which combination of measures best differentiated members of the two groups. Table 1 presents the measures used by Federico and Landis, along with an abbreviation and brief description of each.

Objectives

The objectives of this research were:

1. To identify measures of cognitive styles, abilities, and aptitudes that are related to student achievement within the first 11 modules of BE/E School (i.e., in terms of the amount of subject matter mastered and the time required to complete modules).

2. To derive regression equations employing these cognitive indices that can be used to predict student performance in the modules.

3. To determine whether the predictor pattern changes across the elementary modules of BE/E School.

4. To propose procedures for adapting instruction to student cognitive characteristics so as to improve student achievement and reduce the times to complete the basic modules.

Table 1

Cognitive Characteristics Measured

Cognitive Characteristic	Abbreviation	Description	Measurement Instrument
		Cognitive Style	
Field-Independence vs. Field-Dependence	FILDINDP	Analytical vs. global orientation	Hidden Figures Test, Part I (Ekstrom, French, Harmen, & Dermen, 1976)
Conceptualizing Style	CONCSTYL	Span of conceptual category	Clayton-Jackson Object Sorting Test (Clayton & Jackson, 1961)
Reflectiveness--Impulsiveness	REFLIMPL	Deliberation vs. impulse	Impulsivity Subscale from Personality Research Test, Form E (Jackson, 1974)
Tolerance of Ambiguity	TOLRAMBQ	Inclined to accept complex issues	Tolerance of Ambiguity Scale from Self-Other Test, Form C (Rydell & Rosen, 1966)
Category Width	CATEWIDH	Consistency of cognitive range	Category Width Scale (Pettigrew, 1958)
Cognitive Complexity	COGCOMPX	Multidimensional perceptions of the environment	Group Version of Role Construct Repertory Test (Bieri, Atkins, Briar, Leaman, Miller, & Tripodi, 1966)
		Cognitive Ability	
Verbal Comprehension	VERBCOMP	Understanding the English language	Vocabulary Test, Part I (Ekstrom et al., 1976)
General Reasoning	GENLREAS	Solving specific problems	Arithmetic Aptitude Test, Part I (Ekstrom et al., 1976)
Associational Fluency	ASSOFLUN	Producing similar words rapidly	Controlled Associations Test, Part I (Ekstrom et al., 1976)
Logical Reasoning	LOGIREAS	Deducing from premise to conclusion	Nonsense Syllogisms Test, Part I (Ekstrom et al., 1976)
Induction	INDUCTON	Forming hypotheses to fit certain facts	Figure Classification Test, Part I (Ekstrom et al., 1976)
Ideational Fluency	IDEAFLUN	Generating ideas about a specific type	Topics Test, Part I (Ekstrom et al., 1976)
		Cognitive Aptitude	
General Information	GENLINFO	Recognizing factual information	General Information Subtest, ASVAB
Numerical Operations	NUMROPER	Completing arithmetic operations	Numerical Operations Subtest, ASVAB
Attention to Detail	ATTNDETL	Finding an important detail	Attention to Detail Subtest, ASVAB
Word Knowledge	WORDKNOL	Comprehending written and spoken language	Word Knowledge Subtest, ASVAB
Arithmetic Reasoning	ARTHREAS	Solving arithmetic word problems	Arithmetic Reasoning Subtest, ASVAB
Space Perception	SPACPERC	Visualizing objects in space	Space Perception Subtest, ASVAB
Mathematics Knowledge	MATHKNOL	Employing mathematical relationships	Mathematics Knowledge Subtest, ASVAB
Electronics Information	ELECINFO	Using electronics relationships	Electronics Information Subtest, ASVAB
Mechanical Comprehension	MECHCOMP	Reasoning with mechanical concepts	Mechanical Comprehension Test, ASVAB
General Science	GENLSCIE	Perceiving relationships between scientific concepts	General Science Subtest, ASVAB
Shop Information	SHOPINFO	Knowing shop tools	Shop Information Subtest, ASVAB
Automotive Information	AUTOINFO	Knowing automotive functions	Automotive Information Subtest, ASVAB

Note. These cognitive characteristics and the tests used to measure them are described in detail in Federico and Landis (1979) (Appendix).

APPROACH

Subjects

The original sample consisted of the 172 BE/E graduates who participated in the Federico and Landis (1979) study. Since data regarding module test scores and times of completion were missing or incomplete for 6 of these students, however, analyses were based on data for the remaining 166.

Analyses

Twenty-two stepwise multiple-regression analyses were computed. Criterion variables consisted of (1) the scores obtained by students during their initial attempt at taking the mastery test for the first 11 BE/E modules and (2) the time in hours to complete successfully each of these modules. The predictor variables for all of these analyses were the 24 measures of student cognitive characteristics listed in Table 1.

The subject-matter content of the first 11 modules of the BE/E curriculum is presented in Table 2. These modules were used in the study since students from all ratings must complete them successfully before proceeding to more specialized training. The test score for any of these modules is simply the number of items correct.

Two canonical analyses also were computed using the set of 24 cognitive measures as predictor variables. The two sets of multiple criterion variables used in these analyses consisted of (1) the entire group of the 11 module test scores for the students and (2) the total collection of corresponding times for them to complete these modules. These canonical analyses were calculated to determine the maximum relationships between student cognitive characteristics and (1) their total achievement on the first 11 BE/E modules and (2) the times they required to complete these modules.

Table 2

Subject-Matter Content of First 11 Modules of BE/E School, Course File 69

Module Number	Subject-Matter Content
1	Electrical current--Electron movement, current flow, measurement
2	Voltage--Electromotive force (EMF), magnetism, induction, AC/DC
3	Resistance--Characteristics, resistors, ohmmeters
4	Measuring current and voltage in series circuits--Using the multimeter
5	Relationships of current, voltage, and resistance--Ohm's law, power, troubleshooting series circuit
6	Parallel circuits--Rules for voltage and current, resistance and power troubleshooting
7	Combination circuits and voltage dividers--Solving complex circuits, voltage reference, and dividers
8	Induction--Electromagnetism, inducing voltage, flux density, inductance
9	Relationships of current, counter EMF, and voltage in inductance-resistance circuits--Rise and decay of current and voltage, LR time constants, reactance, phase relationships
10	Transformers--Construction, theory, operation, turns and voltage ratios, efficiency, rectifiers
11	Capacitance--Theory, resistance-capacitance time constant, capacitive reactance, phase and power relationships, capacity design considerations.

RESULTS

The means and standard deviations for module test scores, times to complete the modules, and measures of cognitive characteristics are presented in Table 3; and the intercorrelation matrix of all these variables, in Table 4. The appendices provide summaries of the 22 regression analyses, along with the statistics computed to test the significance of each of these regressions, their standard errors, and their corresponding regression equations using standardized regression weights.

Figures 1 and 2 depict the percent variance of the module test scores and completion times accounted for by the measures of cognitive characteristics in their respective regression analyses. Figure 1 shows that, in 7 of the 11 modules (64%--all but Nos. 3, 7, 8, and 11), measures of cognitive styles and/or abilities contributed more to the prediction of student achievement than did measures of cognitive aptitudes. It also shows that cognitive styles and aptitudes are more important, or account for more variance, in the later modules than the earlier ones; whereas the opposite is true for cognitive abilities. Further inspection of Figure 1 reveals that, in terms of frequency of appearance across the 11 modules, the average percent variance accounted for, and the significant regression weights in the appendix, the following measures are most predictive of student achievement: conceptualizing style, category width, field independence, cognitive complexity, reflection-impulsivity, general reasoning, logical reasoning, verbal comprehension, numerical operations, and space perception.

From Figure 2, it is obvious that, in all the modules, measures of cognitive styles and/or abilities accounted for more of the variance of the times to complete the modules than did measures of cognitive aptitudes. Cognitive styles and abilities appear to be approximately equally important predictors of times through the earlier as well as the later modules; cognitive aptitudes, however, are more predictive in the second than the first half of the modules. The frequency of appearance across modules, the average percent variance accounted for, and the significant regression weights in the appendix show that the more important measures of cognitive characteristics to predict the times to complete the modules are field independence, general reasoning, induction, mathematics knowledge, general science, and automotive information. The single most important predictor of times through the modules is general reasoning.

The results of the two canonical analyses computed between measures of cognitive characteristics and module test scores/times required are provided in Table 5. Only a few variables accounted for the significant relationship between the module test scores and the measures of cognitive characteristics. Low student achievement in modules 2, 6, and 11 is related to low scores on field independence, general reasoning, logical reasoning, ideational fluency, mechanical comprehension, and automotive information.

Several variables accounted for the significant relationship between the times through the modules and the measures of cognitive characteristics. Students with low scores on field independence, general reasoning, mathematics knowledge, and automotive information took longer to complete modules 2, 5, 6, and 9 than did other students.

Table 3

Means and Standard Deviations for Module Test Scores, Times to Complete Modules, and Measures of Cognitive Styles, Abilities, and Aptitudes

Variable	Mean	S.D.
SCORMO1	23.54	1.53
SCORMO2	26.15	2.80
SCORMO3	17.46	1.50
SCORMO4	9.07	.96
SCORMO5	27.87	2.25
SCORMO6	19.60	2.85
SCORMO7	22.07	4.35
SCORMO8	16.74	2.17
SCORMO9	14.87	1.96
SCORM10	15.08	1.61
SCORM11	15.16	1.88
TIMEMO1	5.56	3.59
TIMEMO2	6.93	3.45
TIMEMO3	6.34	2.77
TIMEMO4	8.05	4.68
TIMEMO5	14.27	7.72
TIMEMO6	9.18	4.89
TIMEMO7	19.83	9.60
TIMEMO8	6.43	3.41
TIMEMO9	9.58	4.51
TIMEMO10	6.98	4.06
TIMEMO11	8.55	4.08
FILDINDP	5.25	3.85
CONCSTYL	12.71	4.08
REFLIMPL	3.37	3.16
TOLRAMBQ	5.69	2.01
CATEWIDH	31.72	9.52
COGCOMPX	72.32	17.90
VERBCOMP	9.06	3.21
GENLREAS	8.27	2.87
ASSOFLUN	11.01	4.96
LOGIREAS	2.79	4.54
INDUCTON	59.64	16.77
IDEAFLUN	11.47	4.12
GENLINFO	58.80	6.96
NUMROPER	54.11	7.44
ATTNDETL	51.19	9.52
WORDKNOL	59.43	6.37
ARTHREAS	60.33	8.47
SPACPERC	56.10	11.26
MATHKNOL	60.57	8.16
ELECINFO	60.63	6.36
MECHCOMP	59.68	6.75
GENLSCIE	60.40	7.68
SHOPINFO	57.81	6.81
AUTOINFO	57.52	8.13

Table 4

Intercorrelation Matrix for Module Test Scores, Times to Complete Modules, Measures of Cognitive Styles, Abilities and Aptitudes

	SCORM01	SCORM02	SCORM03	SCORM04	SCORM05	SCORM06	SCORM07	SCORM08	SCORM09	SCORM10	SCORM11
SCORM01											
SCORM02	.41										
SCORM03	.10	.19									
SCORM04	.29	.27	.19								
SCORM05	.31	.37	.22	.31							
SCORM06	.17	.29	.18	.14	.48						
SCORM07	.10	.16	.30	.26	.19	.36					
SCORM08	.34	.42	.25	.22	.33	.34	.24				
SCORM09	.27	.34	.22	.27	.27	.39	.26	.50			
SCORM10	.43	.44	.23	.25	.43	.28	.23	.47	.35		
SCORM11	.34	.31	.22	.24	.37	.33	.33	.38	.34	.38	
TIMEM01	-.27	-.16	.05	-.20	-.12	-.19	-.08	-.05	-.11	-.16	-.20
TIMEM02	-.23	-.49	.00	-.21	-.25	-.19	-.20	-.21	-.23	-.30	-.25
TIMEM03	-.15	-.18	-.09	-.15	-.09	-.23	-.11	-.15	-.19	-.14	-.16
TIMEM04	-.20	-.16	-.05	-.22	-.12	-.29	-.29	-.30	-.34	-.15	-.28
TIMEM05	-.21	-.29	.01	-.34	-.26	-.16	-.19	-.23	-.22	-.23	-.14
TIMEM06	-.14	-.25	-.06	-.22	-.23	-.44	-.18	-.30	-.34	-.25	-.23
TIMEM07	-.20	-.24	-.12	-.27	-.30	-.31	-.33	-.26	-.27	-.24	-.37
TIMEM08	-.28	-.14	-.06	-.14	-.05	-.09	-.13	-.28	-.19	-.14	-.08
TIMEM09	-.37	-.26	-.06	-.29	-.13	-.19	-.06	-.19	-.28	-.12	-.17
TIMEM10	-.19	-.17	-.03	-.21	-.05	-.08	-.11	-.18	-.15	-.25	-.10
TIMEM11	-.20	-.23	-.08	-.23	-.03	-.16	-.14	-.20	-.19	-.11	-.21
FILDINDP	.12	.25	.13	.14	.17	.25	.08	.18	.22	.21	.24
CONCSTYL	.04	.17	-.02	-.06	.07	.14	.03	.11	.22	.06	-.06
REFLIMPL	.05	-.07	.06	.00	-.15	-.10	-.07	-.10	-.13	.02	-.02
TOLRAMBQ	.00	.07	-.03	.14	.06	-.07	-.10	-.07	-.03	-.05	-.05
CATEWIDH	.17	.04	.08	.07	.11	.09	.02	.08	.05	.28	.21
COGCOMPX	-.06	-.03	-.11	-.09	-.01	.00	.06	-.05	-.11	-.10	-.15
VERBCOMP	.23	.30	.13	.11	.28	.12	.09	.18	.11	.24	.14
GENLREAS	.24	.31	.04	.21	.23	.25	.24	.18	.13	.23	.32
ASSOFLUN	.15	.27	.06	.10	.18	.10	.03	.17	.12	.15	.15
LOGIREAS	.24	.20	.08	.15	.20	.19	.30	.20	.17	.20	.34
INDUCTON	.06	.06	-.06	.05	-.00	.10	.06	.22	.10	.09	.07
IDEAFLUN	.07	.18	-.15	-.01	.14	.02	-.07	.01	.15	.04	.18
GENLINFO	.13	.26	.04	.01	.06	.04	-.02	.14	.10	.21	.11
NUMROPER	.06	.07	-.07	.02	.04	-.05	.18	.02	.08	-.01	.12
ATTNDETL	.13	-.03	.02	-.05	-.07	-.06	.05	-.09	.02	-.08	.05
WORDKNOL	.17	.19	-.03	-.00	.17	.07	-.09	.10	.10	.17	.13
ARTHREAS	.15	.07	-.02	.02	.08	.13	.02	.08	.06	.10	.22
SPACPERC	.06	.01	.03	[illegible]	.02	-.04	-.01	.11	.04	.09	.01
MATHKNOL	.23	.20	-.04	.10	.21	.20	.18	.21	.17	.16	.23
ELECINFO	.07	.25	.08	.22	.07	.15	.13	.24	.21	.23	.15
MECHCOMP	.16	.22	.00	.14	.17	.26	.13	.20	.18	.23	.20
GENLSCIE	.18	.24	.05	.15	.12	.19	.06	.18	.18	.15	.16
SHOPINFO	.08	.05	-.04	.07	.05	.07	-.00	.04	-.02	.10	.13
AUTOINFO	.19	.27	.10	.13	.23	.08	.06	.16	.13	.27	.20

	TIMEM01	TIMEM02	TIMEM03	TIMEM04	TIMEM05	TIMEM06	TIMEM07	TIMEM08	TIMEM09	TIMEM10	TIMEM11	FILDINDP	CONCSTYL	RE
SCORM01														
SCORM02														
SCORM03														
SCORM04														
SCORM05														
SCORM06														
SCORM07														
SCORM08														
SCORM09														
SCORM10														
SCORM11														
TIMEM01														
TIMEM02	.42													
TIMEM03	.32	.45												
TIMEM04	.32	.49	.53											
TIMEM05	.50	.44	.44	.47										
TIMEM06	.38	.38	.42	.41	.51									
TIMEM07	.38	.47	.40	.44	.60	.56								
TIMEM08	.17	.34	.26	.31	.21	.34	.37							
TIMEM09	.36	.45	.38	.38	.33	.40	.46	.50						
TIMEM10	.33	.44	.37	.33	.43	.46	.37	.52	.44					
TIMEM11	.34	.42	.37	.40	.30	.47	.40	.45	.53	.55				
FILDINDP	-.19	-.26	-.20	-.22	-.31	-.29	-.28	-.09	-.20	-.14	-.16			
CONCSTYL	-.16	-.15	-.11	-.10	-.23	-.20	-.18	-.10	-.09	-.08	-.01	.12		
REFLIMPL	-.08	.02	.09	.08	.07	.16	.04	-.02	.01	.02	-.05	-.11	-.15	
TOLRAMBQ	-.01	-.16	-.09	-.03	-.16	-.09	-.04	-.03	-.13	-.04	.04	.07	.08	.0
CATEWIDH	-.09	-.15	-.11	-.10	-.10	-.11	-.17	-.04	-.12	-.09	-.10	.13	-.05	.1
COGCOMPX	.03	.09	.03	.06	-.06	.06	.08	.02	.20	.01	.12	-.11	.00	-.2
VERBCOMP	-.21	-.38	-.26	-.20	-.22	-.20	-.19	-.15	-.30	-.19	-.15	.12	.11	-.0
GENLREAS	-.29	-.42	-.24	-.37	-.41	-.41	-.39	-.27	-.38	-.32	-.28	.20	.10	-.0
ASSOFLUN	-.06	-.26	-.20	-.02	-.07	-.06	-.04	-.06	-.18	-.04	-.06	.16	.05	-.0
LOGIREAS	-.15	-.18	-.20	-.24	-.16	-.22	-.22	-.25	-.17	-.13	-.14	.09	.05	-.1
INDUCTON	-.13	-.25	-.35	-.29	-.17	-.11	-.12	-.27	-.19	-.31	-.30	.19	.11	-.1
IDEAFLUN	-.07	-.15	-.14	.02	-.01	-.01	.00	-.01	-.07	-.04	-.08	-.02	.02	.0
GENLINFO	-.00	-.17	-.14	-.08	-.01	-.10	-.00	-.09	-.14	-.14	-.14	.05	.00	.1
NUMROPER	-.16	-.18	-.15	-.13	-.21	-.16	-.18	-.15	-.13	-.20	-.16	.02	.04	-.1
ATTNDETL	-.03	-.01	-.06	-.05	-.02	.11	-.09	-.07	-.01	-.04	-.11	-.02	.02	-.0
WORDKNOL	-.10	-.26	-.18	-.10	-.06	-.10	-.06	-.26	-.27	-.19	-.12	-.00	.08	.0
ARTHREAS	-.09	-.12	-.12	-.12	-.10	-.23	-.22	-.19	-.25	-.23	-.09	.04	-.00	-.0
SPACPERC	.04	-.04	-.02	-.09	.01	-.08	-.08	-.12	-.03	-.08	-.01	.13	-.05	.1
MATHKNOL	-.26	-.30	-.28	-.27	-.36	-.33	-.25	-.22	-.30	-.21	-.18	.25	.13	-.0
ELECINFO	-.10	-.20	-.26	-.20	-.19	-.31	-.16	-.14	-.21	-.17	-.15	.21	.03	-.1
MECHCOMP	-.16	-.27	-.22	-.22	-.13	-.26	-.24	-.33	-.26	-.30	-.21	.20	.07	.0
GENLSCIE	-.12	-.27	-.19	-.17	-.15	-.26	-.18	-.30	-.31	-.29	-.19	.03	.07	-.0
SHOPINFO	-.12	-.10	-.10	-.01	.02	-.15	-.04	-.05	-.10	-.11	-.04	-.03	-.11	-.1
AUTOINFO	-.10	-.25	-.20	-.12	-.06	-.30	-.21	-.11	-.24	-.19	-.08	.10	.05	-.1

Note: $r(164) \geq .193$; $p \leq .005$. $r(164) \geq .148$; $p \leq .025$.

TIMEM11	FILDINDP	CONCSTYL	REFLIMPL	TOLRAMBQ	CATEWIDH	COGCOMPX	VERBCOMP	GENLREAS	ASSOFLUN	LOGIREAS	INDUCTON	IDEAFLUN	GENLINFO	NUMROPER	ATTNDETL	WORDKNOL	ARTHREAS	SPACPERC	MATHKNOL	ELECINFO	MECHCOMP	GENLSCIE	SHOPINFO
-.16																							
-.01	.12																						
-.05	-.11	-.15																					
.04	.07	.08	.01																				
-.10	.13	-.05	.15	-.05																			
.12	-.11	.00	-.21	-.06	-.19																		
-.15	.12	.11	-.04	.12	.25	-.13																	
-.28	.20	.10	-.01	.17	.17	-.08	.35																
-.06	.16	.05	-.05	.12	.13	.03	.41	.17															
-.14	.09	.05	-.13	.05	.17	.03	.22	.36	.10														
-.30	.19	.11	-.16	-.06	.19	.05	.14	.15	.16	.04													
-.08	-.02	.02	.05	.01	.07	.01	.22	.18	.39	.05	.17												
-.14	.05	.00	.10	.03	.09	-.13	.34	.18	.20	.18	-.03	.15											
-.16	.02	.04	-.14	-.06	.10	.03	.18	.31	.05	.11	.06	.26	.16										
-.11	-.02	.02	-.04	-.12	.08	-.00	.00	.03	-.02	.10	.10	.08	-.04	.33									
-.12	-.00	.08	.01	.03	.07	-.07	.54	.15	.30	.12	.07	.22	.43	.21	.01								
-.09	.04	-.00	-.02	.03	.07	-.11	.19	.30	.03	.25	.03	.09	.26	.36	.10	.08							
-.01	.13	-.05	.10	.07	.06	-.11	-.01	.09	.12	-.02	.02	-.01	.13	.07	-.03	.12	.20						
-.18	.25	.13	-.06	.05	.12	-.02	.26	.35	.13	.23	.15	.14	.20	.41	.14	.32	.47	.10					
-.15	.21	.03	-.10	.04	.10	.04	.29	.18	.15	.16	.13	.07	.37	.10	-.10	.42	.21	.25	.40				
-.21	.20	.07	.04	-.03	.12	.01	.20	.26	.14	.16	.21	.15	.37	.17	-.02	.42	.29	.34	.31	.53			
-.19	.03	.07	-.03	.14	.10	.01	.39	.22	.21	.20	.04	.10	.35	.13	-.09	.60	.41	.17	.43	.51	.47		
-.04	-.03	-.11	-.11	.04	.05	-.01	.24	.12	.02	.12	-.11	.07	.31	.11	-.06	.34	.25	.17	.15	.43	.52	.41	
-.08	.10	.05	-.11	.03	.14	-.05	.31	.16	.03	.16	.03	.11	.35	.10	-.11	.29	.21	.14	.19	.47	.50	.34	.53

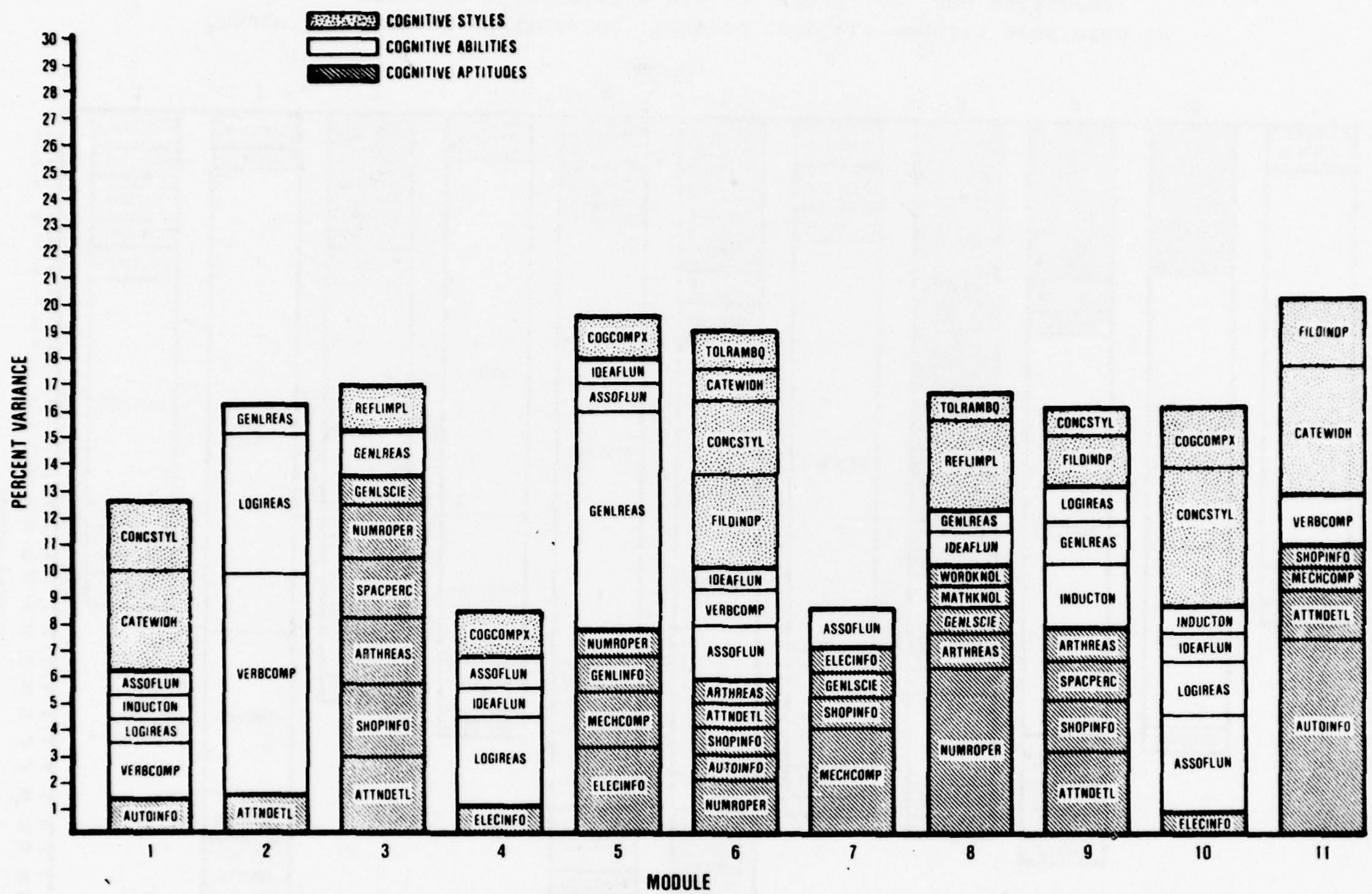

Figure 1. Percent variance of module test scores predicted by measures of cognitive styles, abilities, and aptitudes.

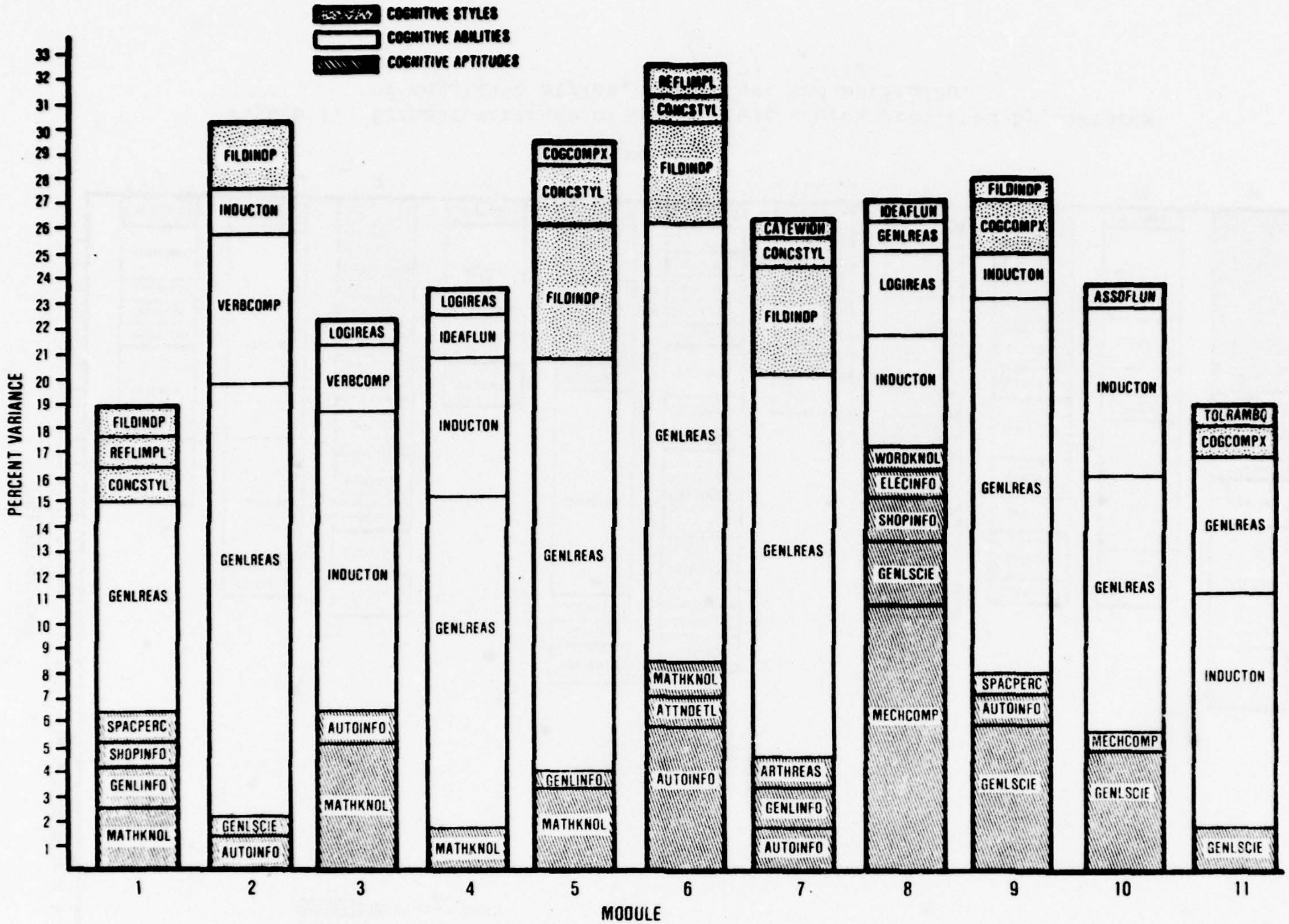

Figure 2. Percent variance of times to complete modules predicted by measures of cognitive styles, abilities, and aptitudes.

Table 5

Canonical Variates for Measures of Cognitive Styles, Abilities, and Aptitudes and Module Test Scores/Times to Complete Modules

Module Test Score	Standardized Canonical Loading	Cognitive Measure	Standardized Canonical Loading
	Module Test Scores[a]		
SCORMO1	-.10	FILDINDP	-.31
SCORMO2	-.42	CONCSTYL	-.02
SCORMO3	.12	REFLIMPL	.13
SCORMO4	.01	TOLRAMBQ	.14
SCORMO5	-.16	CATEWIDH	-.08
SCORMO6	-.23	COGCOMPX	.10
SCORMO7	-.04	VERBCOMP	.03
SCORMO8	.12	GENLREAS	-.39
SCORMO9	-.11	ASSOFLUN	-.15
SCORM10	-.12	LOGIREAS	-.26
SCORM11	-.43	INDUCTON	.17
		IDEAFLUN	-.22
		GENLINFO	.01
		NUMROPER	.19
		ATTNDETL	-.01
		WORDKNOL	-.03
		ARTHREAS	.03
		SPACPERC	.15
		MATHKNOL	-.15
		ELECINFO	.08
		MECHCOMP	-.23
		GENLSCIE	-.14
		SHOPINFO	.19
		AUTOINFO	-.27
	Times to Complete Modules[b]		
TIMEMO1	-.06	FILDINDP	-.20
TIMEMO2	.38	CONCSTYL	-.14
TIMEMO3	-.03	REFLIMPL	.06
TIMEMO4	.09	TOLRAMBQ	-.12
TIMEMO5	.23	CATEWIDH	.00
TIMEMO6	.47	COGCOMPX	.08
TIMEMO7	-.02	VERBCOMP	-.13
TIMEMO8	.07	GENLREAS	-.47
TIMEMO9	.37	ASSOFLUN	-.06
TIMEM10	.02	LOGIREAS	-.03
TIMEM11	-.29	INDUCTON	-.07
		IDEAFLUN	.13
		GENLINFO	.15
		NUMROPER	-.06
		ATTNDETL	.11
		WORDKNOL	.01
		ARTHREAS	-.00
		SPACPERC	.06
		MATHKNOL	-.20
		ELECINFO	-.03
		MECHCOMP	-.10
		GENLSCIE	-.16
		SHOPINFO	.16
		AUTOINFO	-.27

[a]Canonical $R_c = .63$; $R_c^2 = .40$; Wilk's $\Lambda = .11$; $\chi^2(264) = 321.99$; $p = .008$.

[b]Canonical $R_c = .72$; $R_c^2 = .52$; Wilk's $\Lambda = .11$; $\chi^2(264) = 331.86$; $p = .002$.

DISCUSSION AND CONCLUSIONS

The results of the regression analyses indicate that various combinations of measures of cognitive characteristics predict different module test scores as well as times to complete these modules. In addition, there is a pronounced change in the predictor structure across the modules for both student test scores and their completion times. Different modules draw on different predictors to different degrees. The relative importance of the predictors in terms of the amount of variance accounted for varies notably throughout the modules.

When the subject matter of each of the 11 modules is classified according to the task-content matrix of the Instructional Quality Inventory (Wulfeck, Ellis, Richards, Wood, & Merrill, 1978), it was found that the first five modules primarily require the student to remember facts, concepts, principles, and/or rules; and that the last six modules, to use concepts, principles, and/or rules. The findings of the regression analyses for the module test scores demonstrate that, in a relative sense, cognitive abilities are the more important predictors for remembering facts, concepts, principles, and/or rules, and that cognitive styles and aptitudes are the more important predictors for using concepts, principles, and/or rules. Considering the times to master the subject matter for the 11 modules, the more important predictors for speed of student learning are cognitive styles and/or abilities.

Student performance in terms of achievement and rate of acquisition while in the first 11 modules of BE/E School is determined, to some extent, by the cognitive characteristics the students possess prior to beginning this training. Within limits, student proficiency throughout these modules can be predicted by using measures of these characteristics. Changes in the proportion of variance in student performance throughout the modules accounted for by certain cognitive attributes represent shifts in their emphasis during the process of acquiring the course content. These shifts in predictor patterns of cognitive styles, abilities, and aptitudes are related to whether students are required by a module primarily to remember or use facts, concepts, principles, and/or rules. Different cognitive characteristics contribute more or less to student performance at distinct modules or stages of learning.

The results of the regression and canonical analyses indicate that students master more of the subject matter in the first 11 modules of BE/E School if they (1) tend to perceive the environment in a discriminating manner, maximize differences or similarities among objects, to be analytical rather than global in information processing, have a broad range of cognitive categories, and are reflective in their decision making, (2) have high scores in general and logical reasoning abilities as well as verbal comprehension and ideational fluency, and (3) are skilled in numerical operations, space perception, mechanical comprehension, and automotive information. Further, students successfully complete these modules in less time if they (1) can differentiate objects or figures from their backgrounds or contexts, (2) have high scores in general and inductive reasoning abilities, and (3) are skilled in mathematics, general science, and automotive information.

All of these results above suggest several possibilities for developing procedures for adapting instruction to cognitive characteristics (Cronbach & Snow, 1977; Federico, 1978, in press; Federico & Landis, 1979) to improve student performance and lessen their attrition within BE/E School. Students who do not possess those cognitive characteristics identified in this study as important predictors of the amount of subject matter acquired and the rate of learning could be treated in one of three ways.

1. Assuming a sufficient manpower pool, they could be excluded from BE/E School and subsequently those ratings for which this preparatory training is a prerequisite, thus saving scarce instructional resources.

2. They could be included in BE/E School with the provision that they be given special training in deficient areas early in or prior to commencing school, thus increasing their likelihood of graduating.

3. They could be admitted to BE/E School with the understanding that special instructional strategies adapted to their cognitive characteristics will be developed and implemented, thus minimizing the failure rate.

Before these proposals for accommodating instruction within BE/E School can be implemented, cognitive analyses should be conducted of those characteristics that are predictive of student performance. This will assist in understanding the nature of the information processing demands on the student and will allow the identification of pedagogical strategies and remediation schemes for optimizing instruction.

RECOMMENDATIONS

1. The prediction equations derived in this study should be empirically cross-validated, using a large enough number of entering BE/E students to provide sufficiently stable prediction weights. Functions based on larger samples and probably Course File 71 instructional materials could be used to predict student achievement and rate of learning within BE/E School.

2. The tests of cognitive styles and abilities identified as predictive of student performance in this study should be administered to students before they commence BE/E School, to identify those who may benefit from pretraining in deficient areas or the use of specially designed instructional materials that are consistent with their styles and abilities. The development of pretraining and/or special instructional materials will require the following R&D:

a. Information-processing analyses of cognitive styles, abilities, and aptitudes identified as important predictors of student performance in BE/E School.

b. Study of student preferences for and perceptions of different instructional techniques as they may be related to cognitive characteristics.

c. Test and evaluation of adaptive instructional strategies based on the analyses of data resulting from a and b above.

REFERENCES

Bieri, J., Atkins, A. L., Briar, S., Leaman, R. L., Miller, H., & Tripodi, T. Clinical and social judgment: The discrimination of behavioral information. New York: John Wiley & Sons, 1966.

Clayton, M., & Jackson, D. M. Equivalence range, acquiescence, and over-generalization. Educational and Psychological Measurement, 1961, 21, 371-382.

Cronbach, L. J., & Snow, R. E. Aptitudes and instructional methods: A handbook for research on interactions. New York: Irvington Publishers, 1977.

Ekstrom, R. B., French, J. W., Harman, H. H., & Derman, D. Manual for kit of factor-referenced cognitive tests. Princeton, NJ: Educational Testing Service, 1976.

Federico, P-A. Accommodating instruction to student characteristics: Trends and issues (NPRDC Tech. Rep. 79-1). San Diego: Navy Personnel Research and Development Center, October 1978. (AD-A060 587)

Federico, P-A. Adaptive instruction: Trends and issues. In R. E. Snow, P-A. Federico, & W. E. Montague (Eds.), Aptitude, learning, and instruction: Cognitive process analyses. In press.

Federico, P-A., & Landis, D. B. Discriminating between failures and graduates in a computer-managed course using measures of cognitive styles, abilities, and aptitudes (NPRDC Tech. Rep. 79-21). San Diego: Navy Personnel Research and Development Center, June 1979. (AD-A070 748)

Jackson, D. N. Personality research form manual. Goshen, NY: Research Psychologists Press, Inc., 1974.

Orlansky, J., & String, J. Cost effectiveness of computer-based instruction in military training (IDA Paper P-1375). Arlington, VA: Institute for Defense Analyses, 1979.

Pettigrew, T. F. The measurement and correlates of category width as a cognitive variable. Journal of Personality, 1958, 26, 532-544.

Rydell, S. T., & Rosen, E. Measurement and some correlates of need-cognition. Psychological Reports, 1966, 19(I-V19), 139-165. (Monograph Supplement)

Wulfeck, W. H., Ellis, J. A., Wood, N. D., & Merrill, M. D. The instructional quality inventory: I. Introduction and overview (NPRDC Spec. Rep. 79-3). San Diego: Navy Personnel Research and Development Center, November 1978.

APPENDIX

SUMMARIES OF REGRESSION ANALYSES

Table A-1

Summary of Stepwise Regression Analyses for Module Test Scores

Step No.	Variable Entered	Multiple R	R^2	Increase In R^2	F-To-Enter
		Module 1			
1	CATEWIDH	.19	.04	.04	6.45
2	VERBCOMP	.25	.06	.02	3.87
3	CONCSTYL	.29	.08	.02	4.36
4	AUTOINFO	.31	.10	.01	2.17
5	LOGIREAS	.33	.11	.01	1.69
6	INDUCTON	.34	.12	.01	1.70
7	ASSOFLUN	.35	.12	.01	1.61

MS(Regression) = .018; F(7, 158) = 3.22; p < .05; S.E. = .074.
SCORMO1 = 1.88 + .17* CONCSTYL + .27* CATEWIDH - .23* VERBCOMP + .11 ASSOFLUN - .10 LOGIREAS - .11 INDUCTON + .13 AUTOINFO.

Step No.	Variable Entered	Multiple R	R^2	Increase In R^2	F-To-Enter
		Module 2			
1	VERBCOMP	.29	.08	.08	15.01
2	LOGIREAS	.37	.14	.05	10.06
3	ATTNDETL	.39	.15	.01	2.64
4	GENLREAS	.40	.16	.01	2.16

MS(Regression) = 143,529; F(4, 161) = 7.79; p < .001; S.E. = 135.74.
SCORM02 = 115.80 + .21* VERBCOMP + .12 GENLREAS + .19* LOGIREAS + .12 ATTNDETL.

Step No.	Variable Entered	Multiple R	R^2	Increase In R^2	F-To-Enter
		Module 3			
1	LOGIREAS[a]	.21	.04	.04	7.47
2	SHOPINFO	.27	.07	.03	4.74
3	ARTHREAS	.31	.09	.02	4.34
4	SPACPERC	.34	.12	.02	4.24
5	REFLIMPL	.37	.14	.02	3.24
6	GENLREAS	.39	.15	.02	3.25
7	NUMPOPER	.42	.17	.02	3.83
8	ATTNDETL	.45	.20	.03	5.68
9	LOGIREAS	.44	.20	-.01	1.16
10	GENLSCIE	.46	.21	.01	2.35

MS(Regression) = 314,138; F(8, 157) = 5.15; p < .001; S.E. = 247.05.
SCORMO3 = 689.39 - .17* REFLIMPL + 22** GENLREAS - .23** NUMROPER + .20** ATTNDETL + .19* ARTHREAS - .16* SPACPERC + .13 GENLSCIE - .22* SHOPINFO.

[a]This variable removed at Step 9 below.

*p < .05.
**p < .01.

Table A-1 (Continued)

Step No.	Variable Entered	Multiple R	R^2	Increase In R^2	F-To-Enter
		Module 4			
1	LOGIREAS	.19	.03	.03	5.84
2	COGCOMPX	.23	.05	.02	2.92
3	ELECINFO	.25	.06	.01	1.83
4	IDEAFLUN	.27	.07	.01	1.97
5	ASSOFLUN	.29	.08	.01	1.82

MS(Regression) = 50,534.76; $F(5, 160) = 2.92$; $p < .05$; S.E. = 131.47.
SCORMO4 = 708.45 - .14 COGCOMPX + .11 ASSOFLUN + .17* LOGIREAS - .15 IDEAFLUN + .10 ELECINFO.

Step No.	Variable Entered	Multiple R	R^2	Increase In R^2	F-To-Enter
		Module 5			
1	GENLREAS	.29	.08	.08	14.56
2	ELECINFO	.34	.11	.03	6.08
3	MECHCOMP	.37	.14	.02	3.91
4	COGCOMPX	.39	.15	.02	2.89
5	GENLINFO	.41	.16	.01	2.68
6	IDEAFLUN	.42	.17	.01	1.64
7	ASSOFLUN	.43	.18	.01	2.22
8	NUMROPER	.44	.20	.01	2.05

MS(Regression) = 706,203.70; $F(8, 157) = 4.76$; $p < .001$; S.E. = 385.21.
SCORMO5 = 980.47 + .15* COGCOMPX - .26** GENLREAS - .13 ASSOFLUN + .16* IDEAFLUN + .15 GENLINFO - .11 NUMROPER -.30** ELECINFO + .14 MECHCOMP.

Step No.	Variable Entered	Multiple R	R^2	Increase In R^2	F-To-Enter
		Module 6			
1	FILDINDP	.19	.03	.03	5.87
2	CONCSTYL	.25	.06	.03	4.93
3	ASSOFLUN	.29	.08	.02	3.55
4	NUMROPER	.32	.10	.02	3.74
5	TOLRAMBQ	.34	.12	.01	2.50
6	VERBCOMP	.36	.13	.01	2.58
7	CATEWIDH	.39	.15	.02	3.12
8	ATTNDETL	.40	.16	.01	1.75
9	AUTOINFO	.41	.17	.01	1.95
10	SHOPINFO	.42	.18	.01	1.81
11	ARTHREAS	.43	.19	.01	1.77
12	IDEAFLUN	.44	.20	.01	1.52

MS(Regression) = 285,312.60; $F(12, 153) = 3.09$; $p < .001$; S.E. = 303.69.
SCORMO6 = 726.37 - .24** FILDINDP + .14 CONCSTYL - .13 TOLRAMBQ - .16* CATEWIDH + .14 VERBCOMP + .17* ASSOFLUN - .10 IDEAFLUN -.21* NUMROPER + .12 ATTNDETL + .10 ARTHREAS - .14 SHOPINFO + .17 AUTOINFO.

*$p < .05$.
**$p < .01$.

Table A-1 (Continued)

Step No.	Variable Entered	Multiple R	R^2	Increase In R^2	F-To-Enter
		Module 7			
1	MECHCOMP	.20	.04	.04	6.86
2	ASSOFLUN	.23	.05	.01	2.46
3	SHOPINFO	.26	.07	.01	2.02
4	ELECINFO	.27	.08	.01	1.59
5	GENLSCIE	.29	.09	.01	1.80

MS(Regression) = 283,611.60; F(5, 160) = 2.99; p < .05; S.E. = 307.88.
SCORMO7 = 900.68 - .12 ASSOFLUN - .15 ELECINFO - .23* MECHCOMP + .13 GENLSCIE + .13 SHOPINFO.

Step No.	Variable Entered	Multiple R	R^2	Increase In R^2	F-To-Enter
		Module 8			
1	NUMROPER	.25	.06	.06	11.00
2	REFLIMPL	.31	.10	.03	5.85
3	ARTHREAS	.33	.11	.01	2.30
4	IDEAFLUN	.35	.12	.01	2.11
5	LOGIREAS[b]	.36	.13	.01	1.70
6	TOLRAMBQ	.37	.14	.01	1.88
7	GENLSCIE	.39	.15	.01	1.85
8	WORDKNOL	.40	.16	.01	1.52
9	MATHKNOL	.41	.17	.01	1.55
10	GENLREAS	.42	.17	.01	1.52
11	LOGIREAS	.41	.17	-.00	.79

MS(Regression) = 275,077.50; F(9, 156) = 3.53; p < .001; S.E. = 279.10.
SCORMO8 = 325.69 - .19* REFLIMPL - .14 TOLRAMBQ + .13 GENLREAS + .11 IDEAFLUN + .124** NUMROPER - .12 WORDKNOL - .14 ARTHREAS - .13 MATHKNOL + 21* GENLSCIE.

Step No.	Variable Entered	Multiple R	R^2	Increase In R^2	F-To-Enter
		Module 9			
1	ATTNDETL	.17	.03	.03	5.17
2	INDUCTON	.23	.05	.02	4.05
3	GENLREAS	.26	.07	.02	2.80
4	SHOPINFO	.30	.09	.02	3.21
5	SPACPERC	.32	.10	.01	2.66
6	FILDINDP	.35	.12	.02	3.29
7	LOGIREAS	.37	.13	.01	2.33
8	ARTHREAS	.38	.15	.01	2.16
9	CONCSTYL	.40	.16	.01	2.13

MS(Regression) = 179,214.80; F(9, 156) = 3.24; p < .05; S.E. = 235.29.
SCORMO9 = 442.92 - .16* FILDINDP + .11 CONCSTYL + 14 GENLREAS + .14 LOGIREAS + .13 INDUCTON + .15 ATTNDETL - .12 ARTHREAS + .17* SPACPERC - .14 SHOPINFO.

[b]This variable removed at Step 11 below.

*p < .05.
**p < .01.

Table A-1 (Continued)

Step No.	Variable Entered	Multiple R	R^2	Increase In R^2	F-To-Enter
		Module 10			
1	CONCSTYL	.23	.05	.05	8.91
2	ASSOFLUN	.30	.09	.04	6.42
3	COGCOMPX	.33	.11	.02	3.99
4	LOGIREAS	.36	.13	.02	3.78
5	IDEAFLUN	.37	.14	.01	2.00
6	ELECINFO	.39	.15	.01	1.71
7	INDUCTON	.40	.16	.01	1.90

MS(Regression) = 118,140.90; F(7, 158) = 4.29; p < .001; S.E. = 165.91.
SCORM10 = 246.67 + .22** CONCSTYL - .15* COGCOMPX + .13 ASSOFLUN + .13 LOGIREAS - .10 INDUCTON + .12 IDEAFLUN + .12 ELECINFO.

Step No.	Variable Entered	Multiple R	R^2	Increase In R^2	F-To-Enter
		Module 11			
1	AUTOINFO	.27	.07	.07	12.90
2	CATEWIDH	.35	.12	.05	8.89
3	FILDINDP	.38	.15	.03	5.01
4	VERBCOMP	.41	.17	.02	3.59
5	ATTNDETL	.43	.18	.02	3.48
6	MECHCOMP	.44	.19	.01	1.69
7	SHOPINFO	.45	.20	.01	1.57

MS(Regression) = 110,514.70; F(7, 158) = 5.65; p < .001; S.E. = 139.88.
SCORM11 = 224.92 + .12 FILDINDP + .18* CATEWIDH + .16* VERBCOMP - .14 ATTNDETL + .15 MECHCOMP - .12 SHOPINFO + .15 AUTOINFO.

*p < .05.
**p < .01.

Table A-2

Summary of Stepwise Regression Analyses for Time to Complete Modules

Step No.	Variable Entered	Multiple R	R^2	Increase In R^2	F-To-Enter
		Module 1			
1	GENLREAS	.29	.09	.09	15.34
2	MATHKNOL	.34	.11	.03	4.98
3	CONCSTYL	.36	.13	.01	2.49
4	REFLIMPL	.37	.14	.01	2.31
5	FILDINDP	.39	.15	.01	2.12
6	SHOPINFO	.40	.16	.01	2.44
7	GENLINFO	.42	.18	.06	2.90
8	SPACPERC	.44	.19	.01	2.39

MS(Regression) = 50.44; F(8, 157) = 4.60; p < .001; S.E. = 3.31.
TIMEMO1 = 14.12 - .14 FILDINDP - .14 CONCSTYL - .17* REFLIMPL - .21** GENLREAS + .13 GENLINFO + .12 SPACPERC - .15 MATHKNOL - .18* SHOPINFO.

Step No.	Variable Entered	Multiple R	R^2	Increase In R^2	F-To-Enter
		Module 2			
1	GENLREAS	.42	.17	.17	34.25
2	VERBCOMP	.48	.23	.06	12.73
3	FILDINDP	.51	.26	.03	5.94
4	INDUCTON	.53	.28	.02	4.37
5	AUTOINFO	.54	.29	.01	3.26
6	GENLSCIE	.54	.30	.01	1.94

MS(Regression) = 99.15; F(6, 159) = 11.47; p < .001; S.E. = 2.94.
TIMEMO2 = 19.05 - .14* FILDINDP - .17* VERBCOMP - .27** GENLREAS - .15* INDUCTON - .10 GENLSCIE - .10 AUTOINFO.

Step No.	Variable Entered	Multiple R	R^2	Increase In R^2	F-To-Enter
		Module 3			
1	INDUCTON	.35	.12	.12	23.07
2	MATHKNOL	.42	.17	.05	10.15
3	VERBCOMP	.45	.20	.03	5.12
4	AUTOINFO	.46	.21	.01	2.60
5	LOGIREAS	.47	.22	.01	2.23

MS(Regression) = 56.45; F(5, 160) = 9.21; p < .001; S.E. = 2.48.
TIMEMO3 = 15.79 - .12 VERBCOMP - .11 LOGIREAS - .31** INDUCTON - .16* MATHKNOL - .11 AUTOINFO.

*p < .05.
**p < .01.

Table A-2 (Continued)

Step No.	Variable Entered	Multiple R	R^2	Increase In R^2	F-To-Enter
		Module 4			
1	GENLREAS	.37	.13	.13	25.30
2	INDUCTON	.44	.19	.06	11.36
3	MATHKNOL	.46	.21	.02	3.56
4	IDEAFLUN	.48	.23	.02	3.90
5	LOGIREAS	.49	.24	.01	2.09

MS(Regression) = 170.74; F(5, 160) = 9.90; p < .001; S.E. = 4.15.
TIMEMO4 = 19.11 - .27* GENLREAS - .11 LOGIREAS - .25* INDUCTON + .14 IDEAFLUN - .14 MATHKNOL.

Step No.	Variable Entered	Multiple R	R^2	Increase In R^2	F-To-Enter
		Module 5			
1	GENLREAS	.40	.16	.16	32.40
2	FILDINDP	.47	.22	.06	11.53
3	MATHKNOL	.50	.25	.03	7.34
4	CONCSTYL	.53	.28	.02	5.43
5	COGCOMPX	.54	.29	.01	2.34
6	GENLINFO	.54	.30	.01	1.53

MS(Regression) = 484.58; F(6, 159) = 11.11; p < .001; S.E. = 6.60.
TIMEMO5 = 35.48 - .20** FILDINDP - .15* CONCSTYL - .09 COGCOMPX - .31** GENLREAS + .09 GENLINFO - .20** MATHKNOL.

Step No.	Variable Entered	Multiple R	R^2	Increase In R^2	F-To-Enter
		Module 6			
1	GENLREAS	.41	.17	.17	33.87
2	AUTOINFO	.48	.23	.06	12.44
3	FILDINDP	.52	.27	.04	8.64
4	CONCSTYL	.54	.29	.02	4.14
5	MATHKNOL	.55	.30	.01	3.17
6	ATTNDETL	.56	.32	.01	3.25
7	REFLIMPL	.57	.33	.01	2.34

MS(Regression) = 184.24; F(7, 158) = 10.88; p < .001; S.E. = 4.10.
TIMEMO6 = 24.04 - .15* FILDINDP - .12 CONSTYL + .10 REFLIMPL - .29** GENLREAS + .13 ATTNDETL - .15* MATHKNOL - .18** AUTOINFO.

*p < .05.
**p < .01.

Table A-2 (Continued)

Step No.	Variable Entered	Multiple R	R^2	Increase In R^2	F-To-Enter
		Module 7			
1	GENLREAS	.39	.15	.15	29.88
2	FILDINDP	.44	.20	.04	8.61
3	AUTOINFO	.46	.21	.02	3.69
4	GENLINFO	.48	.23	.01	3.04
5	CONCSTYL	.49	.24	.01	2.85
6	ARTHREAS	.50	.25	.01	2.66
7	CATEWIDH	.51	.26	.01	1.64

MS(Regression) = 570.06; F(7, 158) = 8.04; p < .001; S.E. = 8.42.
TIMEMO7 = 43.47 - .18* FILDINDP - .13 CONCSTYL - .09 CATEWIDH - .30** GENLREAS + .15* GENLINFO - .12 ARTHREAS - .15* AUTOINFO.

Step No.	Variable Entered	Multiple R	R^2	Increase In R^2	F-To-Enter
		Module 8			
1	MECHCOMP	.33	.11	.11	19.73
2	INDUCTON	.39	.15	.04	8.38
3	LOGIREAS	.44	.19	.04	7.85
4	GENLSCIE	.46	.22	.03	5.19
5	SHOPINFO	.48	.23	.09	3.77
6	GENLREAS	.49	.24	.01	2.17
7	ELECINFO	.50	.25	.01	2.15
8	IDEAFLUN	.51	.26	.01	1.69
9	WORDKNOL	.52	.27	.09	1.76

MS(Regression) = 57.47; F(9, 156) = 6.42; p < .001; S.E. = 2.99.
TIMEMO8 = 17.08 - .13 GENLREAS - .15* LOGIREAS - .20** INDUCTON + .11 IDEAFLUN - .12 WORDKNOL + .14 ELECINFO - .26** MECHCOMP - .19* GENLSCIE + .14 SHOPINFO.

Step No.	Variable Entered	Multiple R	R^2	Increase In R^2	F-To-Enter
		Module 9			
1	GENLREAS	.38	.15	.15	28.14
2	GENLSCIE	.45	.20	.05	11.47
3	COGCOMPX	.48	.23	.03	6.55
4	INDUCTON	.50	.25	.02	4.28
5	AUTOINFO	.51	.26	.01	2.39
6	FILDINDP	.52	.27	.01	1.64
7	SPACPERC	.53	.28	.01	1.56

MS(Regression) = 133.93; F(7, 158) = 8.73; p < .001; S.E. = 3.92.
TIMEMO9 = 22.19 - .10 FILDINDP + .18 COGCOMPX - .27** GENLREAS - .13 INDUCTON + .09 SPACPERC - .23** GENLSCIE - .11 AUTOINFO.

*p < .05.
**p < .01.

Table A-2 (Continued)

Step No.	Variable Entered	Multiple R	R^2	Increase In R^2	F-To-Enter
		Module 10			
1	GENLREAS	.32	.10	.10	18.60
2	INDUCTON	.41	.17	.07	13.62
3	GENLSCIE	.47	.22	.05	10.36
4	ASSOFLUN	.48	.23	.01	1.84
5	MECHCOMP	.49	.24	.01	1.64

MS(Regression) = 129.29; F(5, 160) = 9.97; $p < .001$; S.E. = 3.60.
TIMEM10 = 22.64 - .23** GENLREAS + .10 ASSOFLUN - .26** INDUCTON - .10 MECHCOMP - .20* GENLSCIE.

Step No.	Variable Entered	Multiple R	R^2	Increase In R^2	F-To-Enter
		Module 11			
1	INDUCTON	.30	.09	.09	16.73
2	GENLREAS	.39	.15	.05	10.81
3	GENLSCIE	.41	.17	.02	3.36
4	COGCOMPX	.42	.18	.01	2.75
5	TOLRAMBQ	.43	.19	.01	1.63

MS(Regression) = 103.33; F(5, 160) = 7.43; $p < .001$; S.E. = 3.73.
TIMEM11 = 16.59 + .09 TOLRAMBQ + .12 COGCOMPX - .22** GENLREAS - .27** INDUCTON - .15* GENLSCIE.

*p < .05.
**p < .01.

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